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AGREEMENT PROTOCOL BETWEEN THE CNES (NATIONAL FRENCH SPACE STUDY CENTER) AND THE SWEDISH SPACE COMMISSION

Anonymous

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AGREEMENT PROTOCOL BETWEEN THE CNES (NATIONAL FRENCH SPACE STUDY CENTER) AND THE SWEDISH SPACE COMMISSION

The National Space Study Center (called the CNES below) and the Swedish Commission for Space Activity (called SBSA) wish to reinforce their cooperation in the area of space activity, in particular in the area of Earth observation.

Considering the agreement between the CNES and the SBSA of October 30, 1974, and considering that the French government has decided to carry out a peaceful national Earth observation satellite program (SPOT) which is being directed by the CNES, and convinced that this program will contribute to world needs in the area of environmental monitoring and a better utilization and protection of natural resources, the Government of the French Republic and the Government of Sweden have exchanged letters on the cooperation relative to the SPOT program. This agreement was signed on , 19__, under the following conditions:

I. SWEDISH CONTRIBUTION TO THE PROGRAM AND GUARANTEES OFFERED BY THE SBSA: /2

1) The SBSA will participate in the first SPOT mission described in Appendix 1. The purpose of this participation is to allow Swedish industry to provide the computer which will be flown on the satellite which agrees with the program development plan given in Appendix II.

2) The SBSA will guarantee payments of the industrial fees for the computer flown on the satellite in agreement with the financial plan given in the financial appendix (Appendix III).

3) The SBSA will pay for the following:

With a ceiling of 30 million Swedish crowns, for 1977 economic conditions. This ceiling will be adjusted every year as a function of the Swedish industrial index in order to take into account economic conditions:

*Numbers in margin indicate pagination of original foreign text.

--All development costs and manufacturing costs for the airborne computer, except for the central memory:

--Part of the launch fees and orbit placement fees equal to the percentage of Swedish participation in the industial fees of the development program of the space segment defined as the ratio of the development costs and fabrication costs of Swedish equipment flown, out of the total space costs;

--A technological development program for computer equipment flown with the purpose of modernizing technology for future applications;

--Modification of the image receiving station at Kiruna to be able to receive SPOT satellite data.

4) The present agreement will be executed under the condition that the industrial contract concluded for developing the computer will include a licensing agreement which will allow the exchange of fabrication data required for producing this equipment in France.

II. GUARANTEES OFFERED BY THE CNES: /3

1) The CNES will provide programming of the satellite.

According to the requirements of SBSA, it will guarantee a percentage of the annual effective use time of the satellite for the different operational modes, at least equal to the percentage of Swedish participation in the program defined in Section I, paragraph 3 of the present Protocol, both for the visibility zones of the receiving station and for the zones having no visibility.

The programming calendar for Sweden will be defined by a common agreement between the CNES and the SBSA.

2) The CNES will provide raw data at the request of SBSA from the main Toulouse receiving station for national use by Swedish users for a marginal support cost and reproduction cost. This will conform with French access policy for data mentioned in the letter exchange between the French government and the Swedish government.

3) The CNES will retain the copyright for reproduction and communication of this data through other users beside the Swedish users.

III. USE OF A SWEDISH IMAGE STATION: /4

The following conditions apply in the case where Sweden uses a SPOT satellite receiving station at Esrange Kiruna at the request of the Swedish National Space Society, called SSC below:

1) The CNES will provide free of charge the operation of the SPOT satellite for transmitting images to the Swedish receiving station during the visibility period of the station, according to the technical possibilities.

2) The CNES will provide all the necessary information for designing receiving equipment and, in a general way, will assist the SSC in any way possible to ensure the flawless operation of the SPOT satellite receiving station.

3) The CNES will provide to SSC any operational information required during the use period and will provide operational coordination among the Toulouse and Kiruna receiving stations.

4) SSC will provide recording, receiving and storage of data transmitted by the SPOT satellite using any technical means available for the visibility period for the station. It will establish a catalogue of correctly recorded data and will communicate this to the CNES.

5) The SSC, upon request, will provide CNES with a copy of any image received at marginal support costs and reproduction costs without restriction on its utilization.

6) The SSC will consult CNES to establish specifications for ground equipment associated with receiving SPOT images and will give preference to French equipment under the condition that it can be provided under reasonable conditions.

7) The SSC will then have available data which can be used by itself and its Swedish users without any restrictions, in accordance with Section II, paragraph 3 of the present Protocol. /5

8) The CNES retains the exclusive right for distributing this data to users

in other countries than Sweden.

IV. RELATIONS WITH THE EUROPEAN EARTHNET SYSTEM:

Assuming that the receiving station located at Esrange, Kiruna will operate entirely within the EARTHNET system framework of the European Space Agency, the CNES would agree to the principle of extending the activities of this station to the reception of satellite SPOT images.

After consultation with the SBSA, it will define the conditions for extending the EARTHNET system which will be mutually acceptable.

V. SWEDISH TELEMETRY, TELECOMMAND AND S BAND TRACKING STATION:

In order to operate the SPOT satellite, the CNES will depend on the use of the tracking, telemetry and telecommand station in the S band which the SSC will establish at Esrange, Kiruna. For this service, the CNES will pay the operational normal costs including the depreciation costs for the station.

Financial and technical details for this use will be determined by an agreement between the CNES and the SSC and will be the topic of a separate agreement.

The CNES and the SSC will coordinate so as to distribute the development costs for telemetry, telecommand and S band tracking stations.

VI. FUTURE MISSIONS: /6

1) If the second SPOT satellite flight model is launched, the CNES will guarantee the same participation to the SBSA as for the first part of the mission, but it is understood that the SBSA will contribute the fraction of the launch fees and orbit placement fees equal to the percentage of its participation in the program.

2) The CNES and the SBSA will support development of equipment and technology for the SPOT program, which will be the base for future Earth observation satellite systems.

3) For future national and international missions which will involve the

use of the SPOT platform, the CNES will continue to use the computer discussed in the present Protocol, to the extent that this computer can be provided by Swedish industry under equitable and reasonable conditions.

VII. ORGANIZATION OF FRENCH-SWEDISH RELATIONS WITHIN THE PROGRAM:

1) The CNES will oversee the project and sign all industrial contracts.

2) The CNES will open a bank account in a Swedish bank. As required by the program and in accordance with the financial appendix, the CNES will assign funds to SBSA corresponding to Swedish participation and according to equipment supplied.

3) The CNES will keep SBSA informed about the status of the project. Once a year the project participants will meet to review the project.

4) The definition of the technology development program mentioned in /7 Article I, 3 is determined by a common accord of CNES and SBSA. The SBSA will take the initiative for organizing the required meetings. The CNES will provide program management and will sign all corresponding industrial contracts.

VIII. MODIFICATIONS:

The present Agreement Protocol can be modified by common agreement at the request of either party if circumstances are substantially changed.

IX. DIFFERENCES:

In the case of differences regarding the interpretation or application of the present Accord, the parties will meet to resolve the differences.

X. DURATION.

This Protocol will remain in force for a time period equal to the period of operation of the first satellite flight model, with the restriction of conditions set forth in letter exchanges.

XI. BEGINNING OF CONTRACT EFFECTIVENESS: /8

After signing by both parties, the present Agreement Protocol in the French language will become effective as soon as the French Republic Government and the Swedish Royal Government have carried out the constitutional requirements required by the letter exchange between the two States. The Agreement Protocol will apply provisionally after signing.

For the National Center for Space Studies,

For the Swedish Commission for Space Activity,

Paris, November 8, 1978

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APPENDIX I

DESCRIPTION OF THE SPOT SYSTEM AND THE FIRST MISSION

This is not a final document and will be revised as needed.

THE SPOT SYSTEM (Preliminary System for Earth Observation) /10

The SPOT system was defined for a global Earth observation coverage program. It will be applied for various scientific disciplines and practical applications.

The first mission will perform a systematic observation and repetitive observation of land masses, with the purpose of terrestrial resource exploration.

The system moves around a standard unit, an orbital platform which can carry payloads adaptable to various missions. This multi-mission platform will provide the necessary interfaces with the Ariane European space vehicle.

The system includes the following:

-- a satellite consisting of a payload and the standard platform;

-- a ground complex consisting of an image receiving station which receives information from the payload and a complex of control stations (which communicate with the platform). Additional image stations can also be supplied by the satellite.

The main elements of the SPOT system are described in Figure 1. The satellite with the first payload is shown in Figure 2.

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GENERAL LAYOUT

SPOT First Mission

S A T E L L I T E	
PAYLOAD	STANDARD PLATFORM
- high resolution instrument visible (range) No. 1 (HRV 1) - high resolution instrument visible (range) No. 2 (HRV 2) - image telemetry	- structure - thermal control - power supply - attitude control - orbital control - on-board management - TM - TC - data collection unit (to be defined)

G R O U N D C O M P L E X	
IMAGE GROUND COMPLEX	CONTROL GROUND UNIT
- image telemetry reception - pre-treatment - storage - dissemination - user services	- monitoring telemetry reception - telecommand transmission - technical control - orbital science - programming of satellite and data pre-treatment

FIGURE 1

--MULTIMISSION PLATFORM /12

The platform consists of two parts:

-- the monitoring equipment compartment consisting of a parallelepiped connected to a central tube. This absorbs the forces and contains the power supply batteries.

-- the orbital control compartment consisting of reservoirs and control tubing for attitude control and orbital control. This compartment can be integrated separately and supports the platform to which the payload is attached.

The platform, in particular the on-board computer, provides coordination of the satellite systems, and especially the following functions:

-- control of payload activities over seven orbits (or fourteen): upon remote programming transmitted by the control station, beginning of picture taking, calibration sequences, orientation of the viewing axis of the HRV instrument, etc.

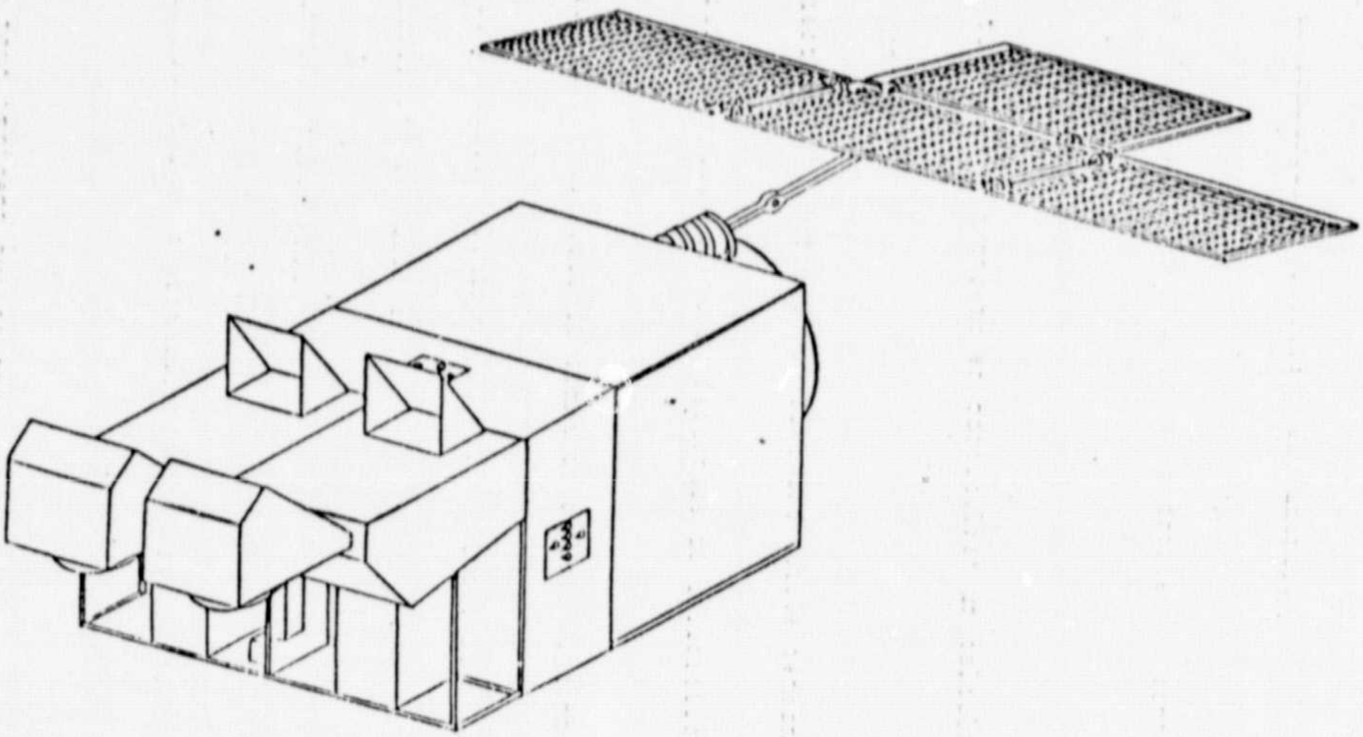
-- adaptation of the command laws so as to compensate for deviations between predicted flight values and real behavior of the satellite (thermal control, orbital maintenance);

-- adaptation of the command laws to subsystems according to their natural aging (residual content of reservoirs, output of solar panels);

-- adaptation of the telemetry format to control functions being performed which vary according to the phases of operation: attitude acquisition and orbital acquisition, picture taking;

-- maintenance of an on-board log and recording of any incidents, especially for any incident which is produced outside the visibility range of the control station;

-- the main characteristics of the platform are given in Table 1.



SPOT SATELLITE
FIRST MISSION

FIGURE 2

SUMMARY OF MAIN CHARACTERISTICS OF THE
MULTIMISSION PLATFORM

Characteristic Dimensions:	
- payload platform	1 800 x 1 900 mm
- solar panels	4 x 1 950 x 1 500 mm
- overall dimensions (with first mission)	8 600 mm
Dry Weight	700 kg
Hydrazine Mass Aloft	300 kg
Maximum Payload Weight	
- mass	650 kg
- static moment	700 m-kg
Nominal Lifetime	2 years
Electrical Power Output of Solar Generator	1 200 W at beginning of mission
Operating Telemetry Command	
- frequency in the band	2025/2120 MHz
- number of commands	510
Operational Telemetry Command	
- frequency in the band	2200/2300 MHz
- emitted power	$\leq$0,5 W
- number of transmitted words	256 8 bit words
- beginning of telemetry	2 kb/s
Altitude Range	570 - 1 200km
Local Hour Angle at the Equator	8 hrs. to 16 hrs.

TABLE 1

- THE FIRST SPOT MISSION /15

- Objectives of the Mission

The following are the objectives of the first mission:

1) To provide a data base of space remote detection data with a high resolution for a large area of the Earth, so as to develop experiments for the utilization of the ground area and exploration of terrestrial resources.

2) Evalute the possibility of lateral optical sighting (visible range and near infrared range) in order to improve observational local repetitiveness in the discrimination of vegetation species.

3) An experiment to carry out limited stereoscopic coverage of investigated regions of geological interest, and to examine data reduction:

   - for photointerpretation;
   - for determining the relief.

4) To qualify a completely static camera prototype so as to define second generation instruments.

5) To flight test a multimission platform and to verify the operation over part of its range of applicability.

6) Promote the development of space remote sensing and define desirable characteristics for the future, possibly in international Earth observation systems.

- Payload:

The first payload consists of two identical high resolution visible range instruments (HRV). The data from these instruments will be transmitted to the ground by a specific telemetry channel (TMCU).

SUMMARY OF MAIN CHARACTERISTICS

DESIGNATION	
FIRST MISSION PAYLOAD	
- HRV Instrument	
. Elementary field of view	20 m (1) 10 m (2)
. Radiometric resolution	0,5 %
. Width of ground trace (nadir)	60 km
(1) Spectral bands	0,50 - 0,59 μm 0,61 - 0,69 μm 0,79 - 0,90 μm
(2) Panchromatic band	0,50 - 0,90 μm
. Maximum off-axis pointing angle	± 26°
- Payload Telemetry	
. Digital frequency (bit rate)	48 Mbit/sec
. Emission in the frequency band	8025 to 8400 GHz

TABLE 2

HRV Instrument

The instrument takes pictures using a mixed sweep mode:

-- an image line is formed by means of a line of detectors in the focal plane of the instrument.

-- the succession of the image lines results from the motion of the satellite along its orbit.

In order to achieve this kind of sweep, there is a line of detectors in the focal plane of the instrument which consists of an assembly of 3000 detectors, in the case of a 20 m x 60 km field sample. There are 6000 detectors for the case of a 10 m sampling step for the main field.

Each of these instruments generates two trains of numerical data at the rate of 24 Mbits/sec each.

The first train of data is generated by three collections of detectors which are associated in the trichromatic operating mode: the second train of data comes from the collection of detectors which operate in the panchromatic operating mode.

The payload telemetry consists of two independent information chains of 24 Mbits/sec each.

Two of the four numerical data trains from the instruments can be multiplexed in frequency and transmitted in real time.

Two recorders provide for storage of the image data which are then reconstituted during the passage of the satellite above the Toulouse image station. The storage capacity for each recorder is on the order of 30 min. each.

- Orbit

The orbit selected for the first mission is a circular orbit and heliosynchronous.

-- average altitude : 822 km

-- inclination: 98.7°

-- duration of one revolution : 101 minutes

-- orbital cycle : 26 days

-- descending node local hour angle : 10 hrs. 30 min.

- Ground Complex /18

The ground complex provides the following three functions:

-- control and command of the satellite in orbit, reconstruction of orbital elements (control ground complex);

-- reception and pretreatment of data acquired from the payload (image ground complex);

-- control of the entire operating system, planning of image taking and data treatment (mission control).

The design of the satellite makes it possible for it to operate practically anywhere around the globe and it can retransmit the information in real time, assuming that the distribution of the image receiving stations can provide reception.

The image ground station can be complemented as requested by additional receiving stations.

The control ground station consists of a single station located at Toulouse during the exploitation routine phase. The required redundancy in the case of failure or during maintenance is provided by the Kourou station. An additional station in Europe could be added. During the launch phase, acquisition

phase and orbital maneuver phase, other stations of the NASA network or the ESA network can be called in.

- Ground Image Complex

At the minimum this complex consists of the following:

-- an image receiving station in the region of Toulouse which will provide reception, decommutation and recording of raw data;
-- a storage complex and copy production complex;
-- a pretreatment and dissemination complex.

The CNES, in consultation with NASA, will provide the complete compatibility between SPOT satellites and Landsat D satellites at the level of data acquisition by the ground complex. /19

APPENDIX 2 /20

DEVELOPMENT PLAN FOR SPOT SYSTEM

1. GENERAL SPOT SYSTEM DEVELOPMENT PLAN

The development plan of SPOT system is based on a very classical satellite concept.

A phase A started at the beginning of 1975 and led to the main mission objectives, selection of the system and technological options which followed research and development work. This led to the decision for the SPOT program.

A two-year phase B (1978-1979) has the purpose of working out detailed systems and will emphasis "hard technologies" issues and will perform the necessary studies and tests. During this phase, we will especially look at the HRV instrument performance, using two mock-ups. One will be used for optical performance

(MFO) and the other for mechanical and thermal performance (MMTH).

Phases C and D will cover the development and fabrication of the SPOT satellite and its associated ground complex. This will take place during the beginning of 1980. This will lead to the launch by the ARIANE at the end of 1983. Over this period, we will study field and test the following mock-ups:

- structural and thermal mock-up (MSTH) for the following:
  . qualify the dimensions of the structure, validate the levels of dynamic environment at various points of the satellite, and qualify the cold gas propulsion system,
  . qualify the satellite thermal model and validate the thermal environment for the equipment.

- prototype No. 1 (P1) will have equipment identical to the flight model equipment with nonruggedize components. This will allow compatibility operational tests of the various equipment and the development of integration and control procedures. Also, compatibility with the ground complex will be established. /21

- prototype No. 2 (P2) or qualification model is completely identical with the flight model. It will be subjected to functional and performance tests under thermal and mechanical environments which are more severe than encountered during launch and orbit. This model will be used as a flight exchange model after repair.

- the flight model (MV) will be tested in an environment which is as close as possible to the orbital and launch conditions.

The development plan given below shows the following important dates:

-- Test results of the optical functional model (MFO) - April 197 ?
-- Test results of the mechanical and thermal model (MMTH) - Feb. 198 ?
-- Delivery of the structural and thermal satellite model (MSTH) - Jan. 198 ?
-- End of integration of the prototype No. 1 (P1) - Jan. 198 ?

-- End of the MSTH tests (except for multimission tests) - March 198 ? /22

-- End of P1 tests (except for multimission) - May 198 ?

-- End of satellite qualification integration model (P2) - Aug. 198 ?

-- Ground receiving complex - September 198 ?

-- Delivery of flight model (MV) - January 198 ?

-- End of qualification test - March 198 ?

-- Receipt of flight model - Aug. 198 ?

-- Launch by ARIANE - November 198 ?

-- Operational readiness - January 198 ?

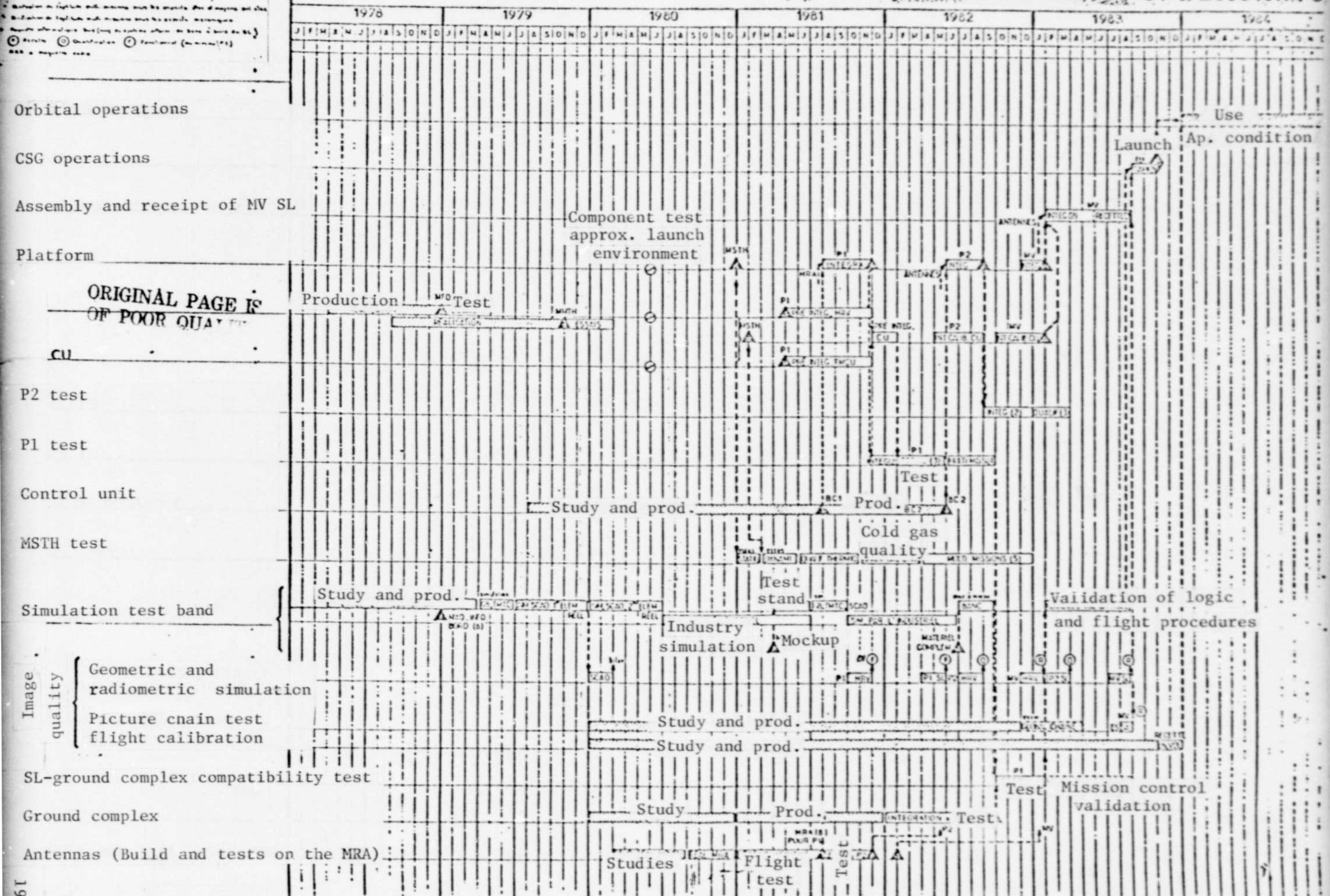
2. DEVELOPMENT OF AIRBORNE COMPUTER

The different versions of the airborne computer will be supplied on the following dates:

- A first electrical test model - December 197 ?
- Two electrical models for the on-board control simulation unit and for logical applications - December 198 ?
- An identification model, but with nonfailure components - August 198 ?
- A qualification model conforming to the flight model with failure components - April 1982
- A flight model - August 1982

DEVELOPMENT PROGRAM, SPOT, DV-O

(01) du 26.01.1978



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APPENDIX 3 /24

FINANCIAL ARRANGEMENTS

1. - SWEDISH FINANCIAL PARTICIPATION

The Swedish financial participation includes the following:

a) Contractual expenses for Swedish industry associated with the work covered by the present Agreement;

b) Contribution to the satellite launch costs defined in paragraph 1.3 of the Agreement Protocol between CNES and SBSA;

c) Modification of the image receiving station at Kiruna.

2. - FINANCIAL FRAMEWORK

The program will be carried out within a financial framework amount to a fixed value of 30 million Swedish crowns for January 1, 1977 economic conditions.

The following is a rough outline of the components:

-- Airborne computer	15	MSK
-- Research and development for future airborne computers	4	MSK
-- Adaptation of the Kiruna image receiving station	3.5	MSK
-- Participation in launch	7.5	MSK
TOTAL	30	MSK

3. - MARGIN FOR TECHNICAL RISKS /25

An additional 3 million crown contribution will cover possible technical risks besides the ones mentioned in the Financial Framework given in paragraph 1. These are associated with the industrial contract for the development of the airborne computer. This amounts to a 20% margin on the estimated industrial contract.

This amount will be made available for technical risks according to an addendum to this Agreement.

4. - ADJUSTMENT FOR VARIATION IN ECONOMIC CONDITIONS

In the financial framework mentioned in paragraph 2, an additional contributions mentioned in paragraph 3 of this Appendix will be calculated on January 1st of each year according to the following price revision formula:

$$\frac{C}{Co} = 0{,}85\ \frac{S}{So} + 0{,}15\ \frac{M}{Mo}$$

with the following definitions:

- C is the revised Swedish contribution
- Co is the contribution of the present financial plan for economic conditions on January 1, 1977
- S is the Swedish salary index (H97) revised on the above date
- So is the Swedish salary index (H97) of January 1, 197 ?
- M is the Swedish material index value (J63) revised on the above date
- Mo is the Swedish material index (J63) on January 1, 1977.

5. - PAYMENT TIME TABLE /26

Within the financial framework discussed in paragraph 2 of this Appendix, the payments will be distributed according to the following schedule:

Year for making funds available	1978	1979	1980	1981	1982	Total
Amount in MSK	3	3	8	12	4	30

The payments discussed in paragraphs 1(a) and 1(b) will be included in reports presented by CNES to the SBSA on May 1 of each year. Considering the time of effectiveness of this Agreement, the call for funds for the year

1978 will be presented on December 20, 1978.

6. - FINANCIAL CONTROL

CNES will open a Swedish bank account for depositing sums received from SBSA for its contractual payments in the favor of Swedish industry, discussed in paragraph 1(a) of this Appendix.

The sums called out for participating in the launch costs of paragraph 1(b) will be paid directly to CNES.